

CLAIMS

1. A variable valve actuation mechanism for an internal combustion engine, the mechanism comprising an intervening drive mechanism, a control shaft, and an actuator, wherein the intervening drive mechanism transmits drive force from a cam provided in a cylinder head of the engine to a valve, the control shaft is engaged with a valve actuation controller provided in the intervening drive mechanism and moves the valve actuation controller in an axial direction to adjust the valve actuation, and the actuator moves the control shaft in an axial direction to adjust the valve actuation, the mechanism being **characterized in that:**

the control shaft has an engaging portion that is engaged with the valve actuation controller and is made of a high strength material, wherein a remaining portion of the control shaft other than the engaging portion is made of a material that is different from the material of the engaging portion, such that the thermal expansion coefficient of the entire control shaft is made closer to the thermal expansion coefficient of the cylinder head.

2. The variable valve actuation mechanism according to claim 1, **characterized in that** the cylinder head is made of a light alloy material, wherein the engaging portion of the control shaft is made of an iron based material, and the remaining portion of the control shaft is made of a light alloy material.

3. The variable valve actuation mechanism according to claim 2, **characterized in that** the light alloy material is an aluminum alloy material or a magnesium alloy material.

4. The variable valve actuation mechanism according to any one of claims 1 to 3, **characterized in that** the remaining

portion of the control shaft other than the engaging portion is made of the same material as the material of the cylinder head.

5. The variable valve actuation mechanism according to any one of claims 1 to 3, **characterized in that** the material and the length of the engaging portion and the material and the length of the remaining portion of the control valve other than the engaging portion are set such that the thermal expansion coefficient of the control shaft is substantially the same as the thermal expansion coefficient of the cylinder head.

6. The variable valve actuation mechanism according to any one of claims 1 to 4, **characterized in that:**

the internal combustion engine has a plurality of cylinders, the intervening drive mechanism is one of a plurality of intervening drive mechanisms each provided for one of the cylinders, the control shaft is common to all the intervening drive mechanisms, the engaging portion is one of a plurality of engaging portions and the remaining portion is one of a plurality of remaining portions;

wherein the thermal expansion coefficient of the cylinder head is greater than the thermal expansion coefficient of the engaging portion of the control shaft, and the thermal expansion coefficient of the remaining portion of the control shaft other than the engaging portion is greater than the thermal expansion coefficient of the engaging portion;

wherein, between each adjacent pair of the intervening drive mechanisms, the thermal expansion coefficient of the control shaft is set lower than the thermal expansion coefficient of the cylinder head, and wherein the ratio of the length of the remaining portion other than the engaging portion to the length of the engaging portion between each

adjacent pair of the intervening drive mechanisms gradually increases as the distance from the actuator to the pair increases.

7. The variable valve actuation mechanism according to claim 6, **characterized in that** the intervening drive mechanisms are arranged substantially at a constant interval, and wherein the length of the remaining portion other than the engaging portion between each adjacent pair of the intervening drive mechanisms increases as the distance from the actuator to the pair increases.

8. The variable valve actuation mechanism according to any one of claims 1 to 7, **characterized in that** the engaging portions of the control shaft and the remaining portions of the control shaft other than the engaging portions are formed separately and are arranged along a common axis while being brought into contact with one another to form the control shaft, and wherein the actuator is provided at one end of the control shaft and urging means is located at the other end of the control shaft to urge the control shaft toward the actuator.

9. The variable valve actuation mechanism according to any one of claims 1 to 5, **characterized in that** the continuity of the material of the remaining portion other than the engaging portion along the axial direction of the control shaft is maintained.

10. The variable valve actuation mechanism according to claim 9, **characterized in that** the remaining portion other than the engaging portion is formed integrally, wherein the engaging portion is buried in and supported by the remaining portion.

11. The variable valve actuation mechanism according to claim 9 or 10, **characterized in that** the engaging portion is engaged with the valve actuation controller by means of a control pin, wherein the engaging portion is provided about the control pin in the control shaft to support the control pin.

12. The variable valve actuation mechanism according to any one of claims 1 to 11, **characterized in that:**

the valve actuation controller is engaged with a control pin supported by the engaging portion and moves as the control shaft moves in the axial direction, and that the intervening drive mechanism includes:

an input portion, wherein the input portion is engaged with the valve actuation controller by means of a first spline mechanism to receive valve drive force from the cam, and transmits the valve drive force to the valve actuation controller; and

an output portion, wherein the output portion is engaged with the valve actuation controller by means of a second spline mechanism to receive the valve drive force from the valve actuation controller, and transmits the valve drive force to the valve,

wherein the helix angle of the first spline mechanism is different from the helix angle of the second spline mechanism, so that, as the control shaft moves axially, the relative positions of the input portion and the output portion are changed and the valve actuation is adjusted.

13. A variable valve actuation mechanism for an internal combustion engine having a plurality of cylinders, the mechanism comprising intervening drive mechanisms each provided for one of the cylinders, a control shaft, and an actuator, wherein each intervening drive mechanism transmits drive force from one of cams provided in a cylinder head of

the engine to a valve, the control shaft is engaged with a valve actuation controller provided in each intervening drive mechanism and moves the valve actuation controllers in an axial direction to adjust the valve actuation, and the actuator moves the control shaft in an axial direction to adjust the valve actuation, the mechanism being **characterized in that:**

the valve clearance of each valve is adjusted by a lash adjuster, wherein the leak down property of the lash adjusters are set different among the cylinders to suppress variation of the valve actuation among the cylinders due to a difference in the thermal expansion coefficient between the control shaft and the cylinder head in relation to the thermal expansion coefficient of each intervening drive mechanism.

14. The variable valve actuation mechanism according to claim 13, **characterized in that**, by creating the difference in the thermal expansion coefficient, the leak down property value of the lash adjuster provided for a cylinder in which the valve actuation value is relatively increased due to a high temperature is set greater than the leak down property value of a cylinder in which the valve actuation value is relatively decreased due to a high temperature.

15. A variable valve actuation mechanism for an internal combustion engine having a plurality of cylinders, comprising intervening drive mechanisms each provided for one of the cylinders, a control shaft, and an actuator, wherein each intervening drive mechanism transmits drive force from one of cams provided in a cylinder head of the engine to a valve, the control shaft is engaged with a valve actuation controller provided in each intervening drive mechanism and moves the valve actuation controllers in an axial direction to adjust the valve actuation, and the actuator moves the

control shaft in an axial direction to adjust the valve actuation, the variable valve actuation mechanism being **characterized in that:**

the valve clearance of each valve is adjusted by a lash adjuster, wherein the pressure of oil supplied to the lash adjusters independently adjusted for each cylinder according to the temperature of the internal combustion engine to suppress variation of the valve actuation among the cylinders due to a difference in the thermal expansion coefficient between the control shaft and the cylinder head in relation to the thermal expansion coefficient of each intervening drive mechanism.

16. The variable valve actuation mechanism according to claim 15, **characterized in that**, by creating the difference in the thermal expansion coefficient, the pressure of oil supplied to the lash adjuster provided for a cylinder in which the valve actuation value is relatively increased due to a high temperature is set smaller than the pressure of oil supplied to a cylinder in which the valve actuation value is relatively decreased due to a high temperature.